RESPONSIVENESS OF SPATIAL PRICE VOLATILITY TO INCREASED GOVERNMENT PARTICIPATION IN MAIZE GRAIN AND MAIZE MEAL MARKETING IN ZAMBIA

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Abstract

The study analyzed the responsiveness of maize grain and maize meal spatial price volatilities to increased government participation in maize grain marketing in Zambia using descriptive statistics and vector auto-regression (VAR). This was achieved by comparing spatial price volatility means and spatial price means for the period under increased government participation with respective means for periods under limited government participation. Also, spatial price volatilities were regressed against own spatial price and cross price means, cross price spatial volatilities, seasonality and arbitrage level. Lastly, the extent of spatial volatility discovery in the two vertical markets (maize grain and maize meal) was discovered from VAR equations. Real monthly price data for January 2003 to May 2011 from 8 major markets were used in the study. Empirical results indicated increased government participation reduced spatial price volatilities for both commodities. The VAR model identified own spatial price mean reduction as the major determinant of spatial price volatility reduction for both commodities compared to other variables. Maize meal spatial price volatility was also determined by one month lagged maize grain spatial price mean. Spatial price volatility for each commodity was higher in months with low prices and lower in months with high prices. Reduced arbitrage exerted more reducing effect on price volatility of maize grain than on maize meal price volatility. Most volatility discovery occured in maize meal market although government intervened in maize grain marketing. The study concluded that increased government participation significantly reduced price volatilities

for both commodities. Moderated government intervention to a level that still guarantees arbitrage by many players, especially in the maize meal market, was recommended.

Key terms

Spatial, price volatility, private sector, government participation, maize grain, maize meal, vertical markets, Zambia.

Introduction

Responsiveness of staple food commodity spatial price volatilities to changes in mean prices resulting from changes in extent of government participation in agricultural commodity markets have been topical issues in Zambia and other developing countries since the inception of structural adjustment reforms in the 1980s (Harvey, 1988; Jansen, 1988; Shawa, 1991; Zyambo, 1993; Johansson, 1998, Govereh, *et al.*, 2008; Wroblewski, *et al.*, 2009; Nyairo, *et al.*, 2010; Gérard, *et al.*, 2011). Chapoto and Jayne (2009) observed that price responses to government intervention take different directions in commodity surplus and commodity deficit regions and this affect various segments of agricultural markets differently. Kähkönen and Leathers (1999) argue that commodity price responses over time and space can encourage or impede private sector participation in commodity marketing. Nyairo, *et al.*, (2010) suggest that these changes can threaten the food security situation through reduced productivity and commodity supply. Chapoto and Jayne (2009) concluded that unintended responses, often associated with lag effects, occur in form of long run commodity price rises in Zambia. Thus, the response of spatial commodity price volatility needs to be considered whenever government intervention targeting prices in agricultural markets changes.

Arbitrage thrives largely on both spatial and serial commodity price volatilities between surplus and deficit regions and between periods by enhancing the distribution function (Schrimper, 2001; Common Market for Eastern and Southern Africa [COMESA], 2010), and by enhancing the storage function (Food and Agriculture Organization [FAO], 2011a). Both volatilities occur naturally due to a mismatch between production which is typically seasonal and consumption which is less seasonal (FAO, 2011). Thus, uniform prices across space and time eliminate private sector participation in commodity marketing by making both distribution and storage functions unprofitable unless under a government subsidy regime to the sector. Government involvement in staple food commodity marketing is generally attracted by high spatial and serial price volatilities especially when household food security is at stake (COMESA, 2010). However, this move often causes food crises due to elimination of private sector in the distribution process (Chapoto and Jayne, 2010) as arbitrage becomes unprofitable under uniform prices. In this situation, processors also opt to procure directly from government agencies.

Maize is the major variable input in maize meal production (Japan Association for International Collaboration of Agriculture and Forestry [JAICAF], 2008). Spatial maize price volatility is bound to have implications on maize meal spatial price volatility as well. Both too high and too low spatial price volatilities have unpalatable implications for an economy (Pindyck, 2004). High volatility affects the marginal value of production and storage, and creates budgetary problems for both producers and consumers. This has been a cause of food riots in some countries especially in drought years (Brown, 2008; COMESA, 2010). On the other hand, low volatility also creates problems for agricultural commodity over time and space. Maize distribution in particular is hampered under low spatial price volatility which creates distribution problems for private sector by reducing the marginal value of distribution. This ultimately reduces commodity availability at demand points.

Maize grain marketing between 2009/10 and 2011/12 marketing seasons has raised concerns on the sustenance of private sector participation in commodity marketing in Zambia. Based on the marketing figures provided by Food Reserves Agency (FRA) and National Early Warning Unit (NEWU) for the 2009/10 to 2011/12 marketing seasons, government increased its purchases from a mere 13% of farm-gate sales in 2008/09 marketing season to almost 83% in the 2010/11 marketing season. In the same period, private sector participation also dwindled, probably due to reduced quantities available for trading and switched procurement by large scale processors from private suppliers to FRA. This action increased FRA supplies to both domestic and foreign markets (Syampaku and Munsanje, 2011).

This study examines the behaviour of maize grain and maize meal spatial price volatilities under 3 different periods, namely, pre-Zambia Agricultural Marketing and Commodity Exchange (ZAMACE) period, active ZAMACE period and post ZAMACE period. The pre-ZAMACE period stretches from January 2002 to September 2007 and was associated with low government participation and active private sector participation without the agricultural commodity exchange environment. The active ZAMACE period ranges from October 2007 to July 2009 and was also associated with low government participation but active private sector participation through the agricultural commodity exchange. Lastly, the post ZAMACE period covered from July 2009 to April 2011 and was associated with high government participation and low private sector participation especially through the agricultural commodity exchange. This study seeks to answer the following research questions: How does increased government participation in maize grain marketing after the 2009/10 marketing season affect spatial maize grain and maize meal price volatility means in Zambia? How do the two spatial commodity price volatility means respond to commodity market price means? Is volatility response influenced by seasonality and level of arbitrage? How much volatility is discovered in each of the two vertical markets? Thus, the overall objective of this study is to analyze the response of spatial price volatilities to increased government involvement in maize marketing in the period August 2009 to May 2011. The general objective of this study will be attained through fulfillment of the following specific objectives. They are to:

(a) compute and compare the mean prices of each commodity under the period of increased government participation with the respective mean prices under the two preceding periods with limited government involvement;

(b) compute and compare the mean spatial price volatilities of the two commodities under the period of increased government participation with the respective price volatility under the two preceding periods with limited government involvement;

(c) determine the response of maize grain and maize meal price volatilities to market prices and other stipulated independent variables and

(d) determine the commodity with more volatility discovery in response to the stipulated independent variables.

To address the above specific objectives, the following study hypotheses are tested:

(a) H_0: The means of maize grain and maize meal prices under increased government participation are not significantly different from the respective means under limited government involvement.

H_1: The means of maize grain and maize meal prices under increased government participation are significantly different from the respective means under limited government involvement.

This hypothesis is to provide information on whether increased government involvement reduces the commodity market price or not. Accepting this hypothesis implies that increased government involvement does not affect maize grain price relative to preceding periods. It also serves as a reference for volatility movements.

(b) H_0: The mean maize grain and maize meal spatial price volatilities under increased government participation are not significantly different from the respective means under limited government involvement.

H_1: The mean maize grain and maize meal spatial price volatilities under increased government participation are significantly different from the respective means under limited government involvement.

The hypothesis helps to determine whether spatial maize grain and maize meal price volatilities reduce or not in response to government intervention in maize marketing. Acceptance of this hypothesis implies increased government involvement does not affect maize grain and maize meal price volatilities relative to preceding periods.

(c) $H_{0.}$ Regression coefficients of stipulated variables are not significantly different from 0.

$H_{1.}$ Regression coefficients of stipulated variables are significantly different from 0.

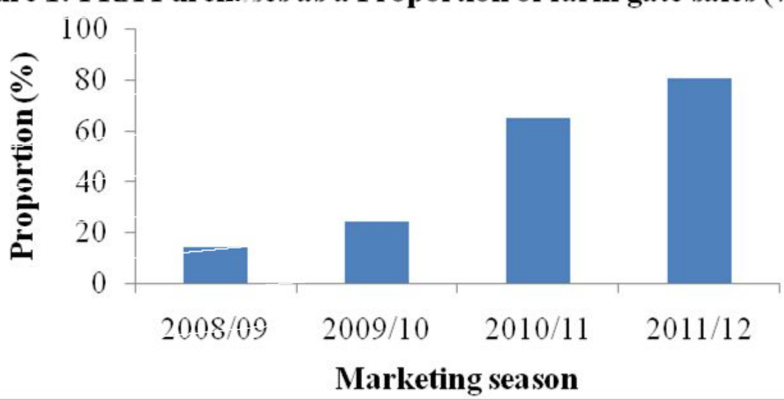
This hypothesis identifies variables responsible for individual commodity price volatility movements and any co-movement. Accepting the null hypotheses implies that price volatility is not a function of the stipulated variables.

It is hoped that information generated from this study will prove useful and relevant to policy makers in making food marketing policy decisions that can have direct effects on various stakeholders. Having presented the introduction which outlines the research problem, objectives and hypotheses, the remaining part of this research paper is organized as follows. Review of literature on forms of government intervention is next and is followed by the analytical framework. The next section is the methodological approach which is followed by results and discussion. The conclusion and recommendations is presented in the last section.

Forms of Government Intervention

The period from August 2009 to May 2011 was associated with various forms of increased government role in maize marketing which in many cases went above Southern Africa Development Community [SADC] recommended levels (SADC, 2009). Firstly, government purchases increased tremendously in this period. Based on FRA and NEWU data, government raised purchases relative to farm-gate sales from approximately 14% in the 2008/09 marketing season to slightly over 24% in the 2009/10 marketing season and to 65% in the 2010/11 marketing season. In the 2011/12 marketing season ,the value increased to approximately 83%. (Figure 1).

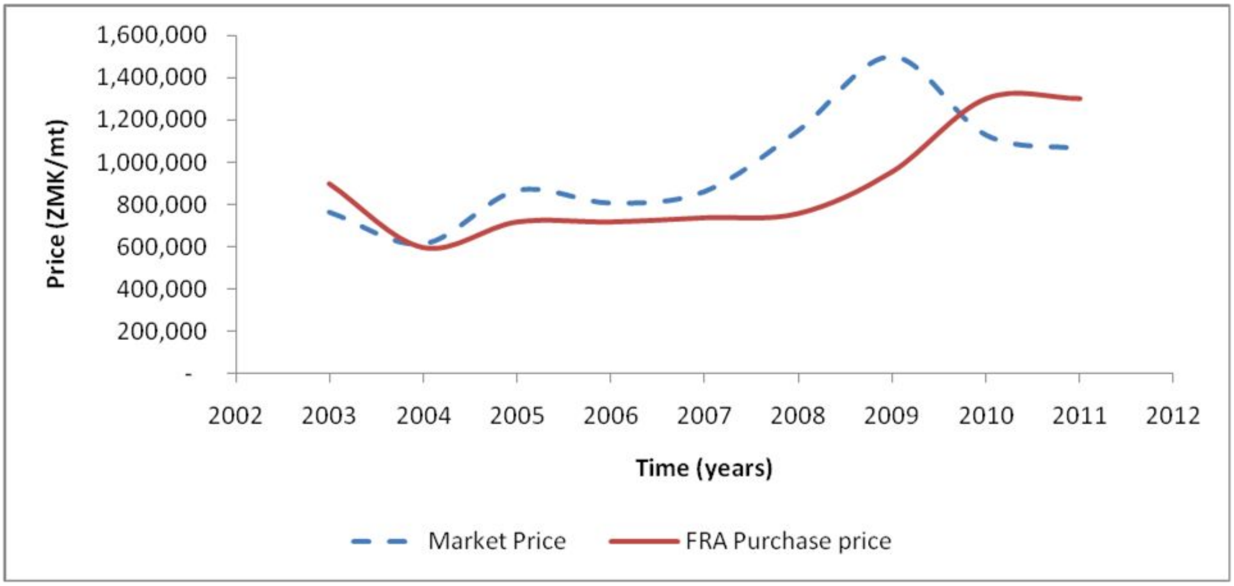
Figure 1: FRA Purchases as a Proportion of farm gate sales (%)



Source: Based on FRA and NEWU data

Increased government purchases were procured at uniform national prices higher than mean market prices (Figure 2).

Figure 3. Relationship between FRA Purchase Price and Market Price (2003-2011)



Source: FRA and Central Statistics Office (CSO) data

In addition to procuring maize at prices above the selling price, the government implemented two additional policy arrangements. The first arrangement had to do with increased carryover stock from previous market seasons and the second was increased sales at heavily subsidized uniform national selling prices. According to national food balance sheets for 2006 to 2011 and FRA purchases data, the carryover stocks increased from just over 5% of FRA purchases in 2006 to 34% in 2009, and finally to slightly above 65% in 2011 (Government of Zambia, 2006; 2007; 2008; 2009; 2010; 2011). The large carryover stocks, in consonance with *a priori* expectation, had a depressing effect on the initial mean market price in each marketing season (Chapoto and Jayne, 2009). In addition to increased carryover stocks, the selling price was subsidized to a level lower than the market price (Wroblewski, et al., 2009). The selling price was higher than the purchase price by approximately 8% in 2007, 64% in 2009, and 7% in 2010 but lower by 38% in 2011 (FRA, 2010; FRA, 2011).

In the period under study, government also imposed restrictions on maize trade in spite of the bumper harvests the country experienced. The government limited export licences during the period with no clear export quota allocated (Govereh, *et al.*, 2008; Wroblewski, *et al.*, 2009; Chapoto and Jayne, 2009).

Increased government purchases and sales, use of uniform national pricing, large carryover stocks, millers' price subsidy and maize grain trade restrictions were associated with reduced arbitrage by private sector participants (Syampaku and Munsanje, 2011). Based on discussion with the Grain Traders Association of Zambia (GTAZ), many large scale arbitragers and processors opted out of the maize farm-gate procurement arrangements in preference for FRA procured maize grain. Reduced volumes of purchase from 86% of farm-gate sales in the 2008/09 season to 35% in the 2010/11 marketing season, and 20% in the 2011/12 marketing season, were largely unfavourable for private sector participants with the result that no maize was transacted through ZAMACE between November 2010 and May 2011 (Syampaku and Munsanje, 2011). Thus, the thrust of the study is to understand the behaviour of spatial commodity price volatility with increased government participation.

Analytical Framework

Commodity price volatility is viewed as price uncertainty (Moledina, *et al.,* 2002), the degree of commodity price fluctuations within a period of time (Gilbert and Morgan, 2010) or extreme price instability (Business and Industry Advisory Committee [BIAC], 2011). Irrespective of the definition applied, high volatility is evident from rapid up and down movements in commodity price, and it is said to be low under little movement (FAO, 2011b). Volatility is often gauged by common measure of dispersion with standard deviation and coefficient of variation being widely used (Moledina, *et al.,* 2002). The strength of standard deviation lies in its capacity to show volatility in absolute terms as opposed to coefficient of variation which gives it in relative terms. Alternative approaches for measuring implied volatility by risk management agencies are also common especially in finance where they are used to estimate volatility locked in charges connected with future prices. This study uses the standard deviation approach because of its wide application, computational simplicity and ease of interpretation (Gilbert and Morgan, 2010). Pindyck (2004) used this approach to study volatility and commodity price dynamics of the energy sector in the USA. Kilima, *et al.*, (2008) applied this approach to measure impacts on market reform of spatial volatility of maize prices in Tanzania.

The simplest approach of estimating spatial price volatility response to increased government participation in marketing uses mean comparisons for periods with both limited government participation and increased government participation. Defining spatial price volatility as the standard deviation of the spatial prices taken in a given month, the monthly volatility values are computed as

$$V_{jt} = \sqrt{\frac{\sum(P_{ijt} - \bar{P}_{jt})^2}{n-1}} \qquad (1)$$

where V_{jt} is the spatial price volatility of the jth commodity in month, t, P_{ijt} is the real price of the jth commodity in the ith spatial market in month, t, $\bar{P}_{jt}$ is the real spatial price mean of the jth commodity in month t, and n is the number of market centres under study in each month t. In this study, j represents the form of the commodity, and it is either m for maize or mm for maize meal. The spatial price volatility mean for one period comprising several months, r, is obtained as given in equation (2)

$$\Pi_{jk} = \frac{\sum_{k=1}^{r} V_{jt}}{r} \qquad (2)$$

where Π_{jk} is the spatial price volatility mean of the kth period, V_{jt} is the spatial volatility mean of the jth commodity in month t, and r is the number of months in the kth period. The value, r, varies depending on the number of months in each reference period. In this study, $r = 57$ for the pre-ZAMACE period, $r = 22$ for the active ZAMACE period, and $r = 22$ for the post-ZAMACE period. Denoting Π_{j1} as the jth commodity spatial price volatility mean for the pre-ZAMACE period, Π_{j2} for the active ZAMACE period and Π_{j3} for the post ZAMACE period, spatial price volatility response to increased government involvement in commodity marketing is gauged by comparing Π_{j3} with Π_{j1} and Π_{j2} using the student's t-test. When $\Pi_{j3} > \Pi_{j1}$ then increased government participation raises spatial price volatility and spatial arbitrage increases compared to the pre-ZAMACE period. The opposite results when $\Pi_{j3} < \Pi_{j1}$. When $\Pi_{j3} = \Pi_{j1}$ then no clear spatial price volatility response to increased government participation. This argument also applies when comparing Π_{j3} with Π_{j2}.

Since commodity prices are the target instruments of government intervention, it is important that spatial commodity price volatility means are studied together with spatial commodity price means. Thus, in this study, spatial commodity price means, $\bar{P}_{jt}$, are averaged for each of the three periods as shown in equation (3)

$$\bar{\mu}_{jk} = \frac{\sum_{k=1}^{r} \bar{P}_{jt}}{r} \quad (3)$$

where $\bar{\mu}_{jk}$ is the spatial price mean of the jth commodity in the kth period, $\bar{P}_{jt}$ is the spatial price mean of the jth commodity in month, t, and r is the number of months in the kth period. Comparing the commodity price means with student's t-test generates information useful in explaining the behaviour of spatial price volatility means under increased government participation in commodity marketing. For example, if $\bar{\mu}_{j3} < \bar{\mu}_{j1}$ when $\Pi_{j3} < \Pi_{j1}$, then the commodity spatial price volatility mean reduces as increased government participation lowers the commodity's mean price. This argument can be advanced for any other possible outcomes.

Understanding how each commodity's spatial price volatility is related to own and cross prices is an important component of this research. It provides information on whether maize grain price volatility is determined by own lagged price volatility and price movements only or by own lagged price volatility and price movements in the maize meal market as well. Since government involvement is in maize grain marketing, the vertical commodity price volatility relationships are important for explaining the direction of government policy impacts. The common approach is to estimate such functions in logarithmic forms to obtain coefficients in elasticity form. Empirical models were estimated as given in equations (4a) and (4b).

$$V_{1t} = \psi_1 + \sum_{i=1}^{k} \lambda_{i1} V_{1t-i} + \gamma_1 V_{2t} + \sum_{j=1}^{q} \sum_{i=0}^{k} \beta_{ji1} P_{jt-i} + \sum_{i=1}^{k} \rho_{i1} V_{2t-i} + \sum_{i=1}^{l} \varphi_{j1} D + \omega_{1t} \quad (4a)$$

$$V_{2t} = \psi_2 + \sum_{i=1}^{k} \lambda_{i2} V_{1t-i} + \gamma_2 V_{1t} + \sum_{j=1}^{q} \sum_{i=0}^{k} \beta_{ji2} P_{jt-i} + \sum_{i=1}^{k} \rho_{i2} V_{2t-i} + \sum_{i=1}^{l} \varphi_{j2} D + \omega_{2t} \quad (4b)$$

where ψ_1 and ψ_2 are constants for maize grain and maize meal price volatilities respectively, V_{1t} and V_{2t} are instantaneous maize grain and maize meal price volatilities, V_{1t-i} and V_{2t-i} are lagged price volatilities at time, $t-i$, P_{jt-i} is a vector of maize and maize meal prices at time, $t-i$, and $i=0,1,\ldots,k$, D is vector of seasonality and arbitrage dummies, respectively, ω_{1t} and ω_{2t} are error terms assumed to be identically and independently distributed with mean 0 and variance, σ^2, that is, $\omega_{1t} \sim iid(0, \sigma^2_{\omega_{1t}})$ and $\omega_{2t} \sim iid(0, \sigma^2_{\omega_{2t}})$, γ_1, γ_2, γ_i, β_{ji1}, β_{ji2}, λ_{i1}, λ_{i2}, φ_{j1} and φ_{j2} are coefficients in elasticity form, with $i=1,2,\ldots,k$, and they are all hypothesized to be equal to 0. The other variables are as defined before except that some now carry one period lagged terms.

The volatility discovery approach used in this study borrows from the Garbade-Silber model developed for price discovery as used in Deka (2006). The approach requires transforming the regression equations (4a) and (4b) into a matrix system of equations in equation (5)

$$\begin{bmatrix} V_{1t} \\ V_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_{01} \\ \alpha_{02} \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} 1-\theta_2 & \theta_2 \\ \theta_3 & 1-\theta_3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} \omega_{1t} \\ \omega_{2t} \end{bmatrix} \qquad (5)$$

In this matrix equation system, X_1 represents all variables in equation (4a) and X_2 all variables in equation (4b), whether unlagged or lagged, including dummies. The matrix, $\begin{bmatrix} 1-\theta_2 & \theta_2 \\ \theta_3 & 1-\theta_3 \end{bmatrix}$, gives coefficients of each variable set scaled to add up to 1 in each matrix row. Determining volatility discovery in the two vertical markets is computed as given in equation (6)

$$\phi_\theta = \frac{\theta_2}{\theta_2 + \theta_3} \qquad (6)$$

When $\theta_3 = 0$, then $\phi_\theta = 1$, and all the volatility is traced to or inherent in the maize meal market. Likewise, when $\theta_3 = 1$, then $\phi_\theta = 0$, and all the volatility is attributed to the maize grain market. When $0 < \theta_\theta < 0.5$, then $0.5 < \phi_\theta < 1$, then, most of the volatility is traced to the maize meal market. Tracing more volatility in one market would suggest that increased government involvement affects that market more than the other. If more volatility is traced to the maize meal market, then although government intervention is targeting maize grain price, it is the maize meal market that experiences more volatility discovery.

Data and Methodology

The study utilizes monthly time series price data for maize grain and maize meal for the period January, 2003 to May, 2011 from 8 main markets in Zambia. This gives 101 data points for each commodity form for the period covered by the study in each market. Nominal prices were converted into real prices by dividing each value with the respective consumer price index (CPI). This is done to ensure that non-stationarity, which is reported to be common with commodity time series is dealt with. Non-stationarity has been attributed to the presence of inflationary trends in time series data (Baulch, 1997; Juselius, 2006; Mafimisebi, 2011). A series is described as non-stationary if its mean values change over time and the variance increases with sample size. In this circumstance, the series is described as possessing a unit root. Such a series is said to be integrated of order "d" with the implication that shocks have permanent effects on it (Gujarati, 1995). Non-stationarity, which leads to estimates that are statistically inefficient owing to spurious regression suggests the presence of causal relations which do not actually exist (Adams, 1992). This phenomenon is common with macro-economic series. Arising from this problem, a requirement, prior to analyzing time series, is correcting for non-stationarity or removing the effect of inflation by deflating the data. The spatial mean and standard deviations for each commodity were computed for each month averaged for each of the three periods indicated and student's t-tests were used for their period mean comparisons. Prices were in Zambian Kwacha (ZMK) and the exchange rate in the entire period ranges between ZMK 3,500 and ZMK 5,400 per USD 1.00 (Bank of Zambia, 2011).

The period January 2003 to May 2011 is divided into 3 sub-periods. January 2003 to September 2007 is designated as Period 1 with 57 data points and comprised data collected in the pre-ZAMACE period. October 2007 to July 2009 is Period 2 with 22 data points and comprised data collected during active ZAMACE period. In both periods, government participation was limited. Lastly, August 2009 to May 2011 is Period 3 with 22 data points and it is a period characterized by very intense government participation. Period 3 is alternatively referred to as post ZAMACE period.

Vector Auto Regression (VAR) model was estimated in logarithm form using ordinary least square approach and transformed into a matrix system for vertical market volatility analysis. Model specification is as indicated in equations (4a) and (4b). Vertical market spatial price volatility discovery was compared using the Garbade-Silber Model as discussed in equations (5) and (6).

Use of dummies to capture different agribusiness environments is a common practice in regression models. Seasonality is generally represented by dummies (Kilima, *et al.*, 2008; Baulch, *et al.*, 2008; Nielson, *et al.*, 2009). This study uses 2 dummies to capture seasonality and arbitrage influence on commodity volatility. The seasonality dummy captured the volatility behaviour under varying seasons, and it was given the value of 1 for April to July when maize price is normally depressed and the value of 2 for August to March when price is rising. The arbitrage dummy captures volatility behaviour changing arbitrage scale and has the value of 1 for periods when large scale arbitrage is not done through ZAMACE and the value of 2 for periods when ZAMACE is actively involved in maize marketing. Short run effects were explained by instantaneous variables and long run effects were captured by dynamic variables (Koutsoyiannis, 1977; Beardshaw, 1992; Banerjee, *et al.*, 1993; Gujarati, *et al.*, 2012).

Results

Maize Grain Price and Volatility Comparisons

Results for mean price volatility comparisons are given in Table 1 and they indicate a general price volatility reduction with corresponding price reduction under increased government participation.

Table 1. Mean Grain Maize Price and Volatility Comparisons

Parameter		Pre ZAMACE period (low government role)	Post ZAMACE period (high government role)	Active ZAMACE period (low government role)	Post ZAMACE period (high government role)
Spatial price means	Value (ZMK/kg)	692.01	570.84	754.23	570.84
	% increase	(17.5)		(24.3)	
	Probability	0.001743		0.000867	
	Observation	***		***	
Spatial price volatility means	Value (ZMK/kg)	178.34	97.54	272.89	97.54
	% increase	(64.3)		(45.3)	

The mean spatial maize price under increased participation was lower than the mean in the pre-ZAMACE period by 17.5%, and lower than the mean during the active ZAMACE period by 24.3%. Results also show that the mean price under increased participation was statistically significantly lower compared to values in the 2 previous periods at 1% level of significance. Interestingly, the mean price volatility movements were strongly linked to mean price movements. Empirical results showed that the mean price volatility of ZMK 97.54 under increased government participation was lower by 45.3% than ZMK 178.34 in the pre-ZAMACE period and by 64.3% than ZMK 272.89 in the ZAMACE active period. In both cases, the t-test indicated the mean price volatility was statistically significantly lower at 1% level of significance. Thus, by implementing policies that reduce price, the government was indirectly reducing price volatility as well.

Maize Meal Price and Volatility Comparisons

Like in maize grain price and its volatility comparisons by period, the maize meal price volatility also witnessed declining patterns under increased government participation compared to preceding periods (Table 2).

Table 2. Mean Maize Meal Price and Volatility Comparisons

Parameter		Pre ZAMACE period (low government role)	Post ZAMACE period (increased Government role)	Active ZAMACE period(low government role)	Post ZAMACE period (increased Government role)
Spatial price mean	Values (ZMK/kg)	1003.24	812.58	1064.53	812.58
	% increase	(19.0)		(23.7)	
	Probability	0.000306		0.000659	
	Observation	***		***	
Spatial price volatility	Values (ZMK/kg)	114.71	98.50	353.82	98.50
	% increase	(14.1)		(72.2)	

The mean price of ZMK812.58/kg under increased government participation was lower by 19.0% compared to the mean price of ZMK1003.24/kg in the pre-ZAMACE period, and by 23.7% compared with the mean price of ZMK1064.53/kg in the active ZAMACE period. Moreover, the mean price was statistically significantly smaller than the mean prices in the 2 previous periods at 1% level of significance. Like in the case of maize grain, the mean spatial price volatility movements were also linked to the mean price movements. Price volatility reduced by 72% under increased government participation from the active ZAMACE period mean, and by 14% compared with the pre-ZAMACE period mean. The price volatility means were statistically different at 5% level of significance.

Commodity Volatility Comparisons

Price volatility comparisons for maize grain and maize meal means are given in Table 3.

Table 3. Commodity mean volatility comparisons

	Pre-ZAMACE period		Under ZAMACE period		Increased Government participation	
Commodity	Maize	Maize meal	Maize	Maize meal	Maize	Maize meal
Means (ZMK/kg)	178.34	114.71	272.89	353.82	97.54	98.50
Proportion of previous mean			1.3 times larger	3.1 times larger	2.8 times smaller	3.6 times smaller
t-test Probability	0.000647		0.486703		0.898723	

In the active ZAMACE period, the spatial price volatility mean for maize meal was 3.1 times larger than in the pre-ZAMACE period whereas that of maize grain was only 1.3 times larger. Under increased participation, the spatial price volatility mean for maize meal was 3.6 times smaller than the mean in the active ZAMACE period compared to 2.8 times for maize grain Thus, the maize meal spatial price volatility mean movements were found to be much more drastic compared to that of maize grain.

The t-test result indicated that increased large scale arbitrage and increased government participation tended to converge price volatility in the two vertical markets. The two volatility means which were significantly different in the pre-ZAMACE period were not significantly different in the active ZAMACE and post-ZAMACE periods. Thus, whereas increased large scale arbitrage raised the spatial volatility means, increased government participation reduced them and brought them to parity.

Causes of Commodity Price Volatility

Results of the two estimated volatility functions are given in Table 4. The table showed weak vertical price linkages between maize grain and maize meal price volatilities.

Table 4. Mean Price and Volatility Values

Parameter	Maize price volatility (V_{1t})			Maize meal price volatility (V_{2t})		
	Value	t-value	Probability	Value	t-value	Probability
Constant	(2.8352)**	(2.4735)	0.0153	(0.8251)ns	(0.6247)	0.5337
V_{2t} coefficient	(0.0928)ns	(0.9889)	0.3254			
V_{2t-1} coefficient	(0.0521)ns	(0.5284)	0.5985	0.5082***	5.2711	0.0000
P_{2t} coefficient	(0.1845)ns	(0.3323)	0.7405	4.2244***	9.7660	0.0000
P_{2t-1} coefficient	0.1531ns	0.2904	0.7722	(3.1846)***	(6.5720)	0.0000
P_{1t} coefficient	2.7630***	9.8448	0.0000	0.2640ns	0.5851	0.5599
P_{1t-1} coefficient	(1.7201)***	(5.0416)	0.0000	(0.8813)**	(2.0902)	0.0394
V_{1t} coefficient				(0.1159)ns	(0.9889)	0.3254
V_{1t-1} coefficient	0.3592***	3.9298	0.0002	0.1104ns	1.0044	0.3179
AD coefficient	0.2723*	1.6711	0.0982	0.1337ns	1.0501	0.2965
SD coefficient	(0.5886)***	(4.4483)	0.0000	(0.2358)**	(2.1350)	0.0355
R^2		0.656432		(0.623442)		
Adjusted R^2		0.622076		0.585786		
S.E. of Regression		0.367836		0.411046		
Sum of squared residuals		12.17730		15.20630		
Log likelihood		(36.61401)		(47.72082)		
F-statistic		19.10635		16.55634		

Maize grain spatial price volatility was strongly related to instantaneous and lagged maize price, own lagged price volatility and seasonality. The coefficients were significantly different from 0 at 1% level of significance. Volatility was weakly related to arbitraging with the coefficient being significant at only 10% level of significance. Increase in arbitrage, as is the case under ZAMACE, also increased spatial maize grain price volatility. Instantaneous maize grain price movement was the major cause of the commodity's spatial price volatility movements. Moreover, the inverse relationship with seasonality dummy suggested that volatility was high in the months of April to July (when prices are generally low) and low during August to March (when prices are generally high). This could be attributed to the increased role of FRA sales especially between November and March. Maize meal price and maize meal price volatility, whether instantaneous or lagged, were not identified to cause any significant changes in the spatial maize grain price volatility, and thus, their movements do not cause maize grain spatial price volatility.

Maize meal price volatility was strongly related to own lagged volatility, instantaneous and lagged maize meal price with coefficients being significantly different from 0 at 1% level of significance. Response to lagged maize grain price and seasonality was also strong with coefficients being significant at 5% level of significance. Thus, government policy targeting maize grain price also affected spatial maize meal price volatility. However, instantaneous maize price, instantaneous and lagged maize price volatility and maize arbitraging, were found not to cause spatial maize grain price volatility. Instantaneous maize meal price movement was also identified as the major cause of the commodity's spatial price volatility movements.

Inter-Market Price Volatility Discovery

Results for volatility discovery indicated that although government intervention was in the maize grain market, most volatility discovery took place in the maize meal market (Table 5).

Table 5 Commodity volatility discovery

Factors	Relative volatility discovery			
	ϕ	Market	$1-\phi$	Market
Instantaneous commodity prices	0.93010	Maize meal	0.06990	Maize grain
Lagged commodity prices	0.55045	Maize meal	0.44955	Maize grain

Commodity price volatility discovery was found to be larger in maize meal market compared to the maize grain market. Price volatility induced by instantaneous commodity prices indicated that 93% occured in the maize meal market with the remaining 7% taking place in the maize grain market. With respect to lagged prices, almost 55% of volatility was discovered in the maize meal market while the other 45% was attributable to the maize grain market. Thus, price volatility discovery induced by lagged prices was more balanced compared to that induced by instantaneous prices. In the case of lagged commodity price volatility, slightly over 65% of the price volatility discovery took place in the maize meal market and the balance of 35% occurred in the maize grain market. Thus, price volatility discovery was relatively higher in the maize meal market compared to the maize grain market. The high spatial price volatility discovery in the maize meal market could be attributed to the level at which government intervenes in the maize grain market. Government directly influences the price of maize procured by FRA which becomes the major source for millers especially after August of each year.

Findings from this research are in concordance with those by Garcia-Salazar, *et al.*, (2012) in grain prices in Mexico. Garcia-Salazar, *et al.*, (2012) found that eliminating government's role in grain marketing increases spatial price volatility which attracts high private sector arbitrage and speculation. However, findings in this study contradict those by Negassa (1998) in Ethiopia and Govereh, *et al.*, (2008) in Zambia. According to Negassa (1998), increased government's role in grain marketing in Ethiopia led to high spatial grain price volatility among major markets and increased risk of arbitrage. Govereh, *et al.*, (2008) observed that there was no clear linkage between increased government's role and volatility reduction in grain marketing. On the influence of seasonality, results reported in this study tally with findings by Kilima, *et al.*, (2008) and Karali and Thurman (2010) that grain price volatility is highly seasonal.

Conclusion

The study established that increased government participation in maize grain marketing reduces spatial maize grain and maize meal price volatilities in Zambia and moved them towards parity. Factors causing price volatility were largely commodity specific except for maize grain price which affected both the maize grain and maize meal price volatilities. Maize grain and maize meal spatial price volatilities were mainly caused by their respective instantaneous prices. Moreover, maize meal spatial price volatility was more responsive to increased government participation compared to maize grain spatial price volatility. Furthermore, volatility discovery took place more in the maize meal market than in the maize grain market under various factors. Instantaneous commodity price induced most of the volatility discovery in maize meal compared to other factors. We recommend that since government intervention in maize grain marketing is perennial, it is important that intervention be moderated to levels that do not eliminate spatial arbitrage for both maize grain and maize meal. As volatility discovery was more in the maize meal market, which serves large cities, it is important that spatial volatility is guaranteed through accessibility by all types of arbitragers to stocks managed by FRA.

5. References

Adams, C. S., 1992. Recent Developments in Econometric Methods: An application to the Demand for Money in Kenya. AERC special paper 15.

Baulch, B., 1997. Testing Food Market Integration Revisited. *Journal of Development Studies, 33(4): 512–534*

Baulch, B., Mamsen, H., Traung, D.L. and Tam, T.N.M, 2008. Spatial Integration of Paddy Markets in Vietnam. *Journal of Agricultural Economics, 59(2): 271-295*

Beardshaw, J. 1992. Economics: A Student Guide, Pitman, UK, 3rd Edition

Banerjee, A., Dolado, J., Galbraith, J.W. and Hendry, D.F., 1993. Co-Integration, Error Correction, and the Econometric Analysis of Non-Stationary Data. Oxford University Press.

Bank of Zambia, 2011. Historical Series of Exchange Rates Between Zambian Kwacha (ZMK) Against Other Currencies. *www.boz.zm/exchange_rates*

BIAC, 2011. Price Volatility in Food and Agricultural Commodity Markets: Policy Options on how to better Mitigate and Manage the Risks associated with the Price Volatility of Food and other Agriculture Commodities, Paris, France *http://www.biac.org/statements/agr/11_06_PriceVolatilityinFoodandAgriculturalCommodityMarkets.pdf*

Brown, O., 2008. From Feast to Famine: After Seven (relatively) Good Years, What now for Commodity Producers in the Developing World? An International Institute for Sustainable Development Commentary, *http://www.iisd.org/pdf/2008/com_feast_famine.pdf*

Chapoto, A. and Jayne, T. S., 2009. The Impacts of Market Interventions on Maize Price and Predictability: Evidence from Eastern and Southern Africa. Michigan State University International Development Working Paper 102

Chapoto, A. and Jayne, T.S., 2010. Do Market Interventions Promote Food Price Stability? Evidence from Eastern and Southern Africa. COMESA – CAADP Programme and Alliance for Commodity Trade in Eastern and Southern Africa conference. *http://www.aec.msu.edu/fs2/gisama/Session_2-Effects_Market_Interventions_on_Price_Stability-Chapoto.pdf*

COMESA, 2010. Variations in Staple Food Prices: Causes, Consequence, and Policy Options. Maputo,Mozambique.*http://www.aec.msu.edu/fs2/aamp/seminar_3/AAMP_Maputo_food_price_variability_synthesis%20.pdf*

Deka, D., 2006. Price Discovery of Energy Derivatives at Indian Exchanges, Paper submitted to International Management Institute, New Delhi, India. *http://www.the-ira.org/documents/price_discovery.pdf*

FAO, 2011a. Policy Options to Address Price Volatility and High Prices: The State of Food Insecurity in the World. *http://www.fao.org/docrep/014/i2330e/i2330e05.pdf*

FAO, 2011b. Price Volatility and Food Security Report, Rome, Italy. *http://www.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/HLPE-price-volatility-and-food-security-report-July-2011.pdf*

FRA, 2010. Marketing and Trade Services, Lusaka, Zambia. *http://www.fra.org.zm/index.php?option=com_content&view=article&id=65:marketing-a-trade-services&catid=41:marketing-a-trade-services&Itemid=92*

FRA, 2011. Modalities for Sale of White Maize to Local Millers, Lusaka, Zambia. *http://www.fra.org.zm/images/tenders/modalities%20for%20sale%20of%20white%20maize%20to%20local%20millers.pdf*

Garcia-Salazar, J.A., Skaggs, R.K. and Crawford, T.L., 2012. World Price, Exchange Rate and Inventory Impacts on the Mexican Corn Sector: A Case Study of Market Volatility and Vulnerability, *Interciencia, 37(7):498-505*. http://www.interciencia.org/v37_07/498.pdf

Gérard, F., Alpha A., Beaujeu, R., Levard, L., Maitre d'Hotel, E., Rouille d'Orfeuil, H., Bricas, N., Daviron, B., Galtier, F. and Boussard J.M., 2011. Managing Food Price Volatility for Food Security and Development. *http://www.interreseaux.org/IMG/pdf/Managing_Food_Price_Volatility_for_Food_Security_and_Development_Grema.pdf*

Gilbert, C.L. and Morgan, C.W., 2010. Food Price Volatility, *The Royal Society Journal, 365 (1554):3023-3034.* *http://rstb.royalsocietypublishing.org/content/365/1554/3023.full.pdf+html*

Govereh, J., Jayne, T.S. and Chapoto, A., 2008. Assessment of Alternative Maize Trade and Market Policy Interventions in Zambia, Food Security Research Project Working Paper No. 33, *http://www.aec.msu.edu/fs2/zambia/wp_33.pdf*

Government of Zambia, 2006. National Food Balance Sheets for the 2006/07 Marketing Year, Ministry of Agriculture and Livestock, Lusaka, Zambia

Government of Zambia, 2007. National Food Balance Sheets for the 2007/08 Marketing Year, Ministry of Agriculture and Livestock, Lusaka, Zambia

Government of Zambia, 2008. National Food Balance Sheets for the 2008/09 Marketing Year, Ministry of Agriculture and Livestock, Lusaka, Zambia

Government of Zambia, 2009. National Food Balance Sheets for the 2009/10 Marketing Year, Ministry of Agriculture and Livestock, Lusaka, Zambia

Government of Zambia, 2010. National Food Balance Sheets for the 2010/11 Marketing Year, Ministry of Agriculture and Livestock, Lusaka, Zambia

Government of Zambia, 2011. National Food Balance Sheets for the 2011/12 Marketing Year, Ministry of Agriculture and Livestock, Lusaka, Zambia

Gujarati, D. N., 1995. *Basic Econometrics*, New York, USA, McGraw hill, 3rd edition.

Gujarati, D.N., Porter, D.C. and Gunasekar, S., 2012. Basic Econometrics, New Delhi, India, McGraw, 5th Edition

Harvey, C., 1988. ed., Agricultural Pricing Policy in Africa: Four Country Case Studies, University of Susses, UK

JAICAF, 2008. The Maize in Zambia and Malawi, Sozosha Ltd, Tokyo, http://www.jaicaf.or.jp/publications/Zambia.pdf

Jansen, D., 1988. Trade, Exchange Rate and Agricultural Pricing Policies in Zambia: The Political Economy of Agricultural Pricing Policy. World Bank Comparative Studies, Washington D.C., USA

Johansson, R.C., 1998. National and Household Food Security: Effects of Zambian Economic Reform. Dept. Applied Economics, University of Minnesota http://pdf.usaid.gov/pdf_docs/PNACJ637.pdf

Juselius, K., 2006. The Co-integration VAR Model: Methodology and Applications. Oxford University Press (manuscript), UK

Kähkönen, S. and Leathers, H., 1999. Transaction Costs Analysis of Maize and Cotton Marketing in Zambia and Tanzania, Technical Paper No. 105, *SD Publication Series Office of Sustainable Development Bureau for Africa.* http://pdf.usaid.gov/pdf_docs/PNACF335.pdf

Karali, B. and Thurman, W.N., 2010. Components of Grain Futures Price Volatility, *Journal of Agricultural and Resource Economics 35(2):167–182.* http://ageconsearch.umn.edu/bitstream/93205/2/JARE%2cAug2010%2c%2301%2cpp167-182.pdf

Koutsoyiannis, A., 1977. Theory of Econometrics, Second Edition, MacMillan Publishers, UK

Mafimisebi, T.E., 2008. Long-run Price Integration in the Nigerian Fresh Fish Market: Implications for Marketing and Development. *Delhi Business Review*, *9(1): 55-67*

Mafimisebi, T.E., 2011. Spatial Price Equilibrium and Fish Market Integration in Nigeria: Pricing Contacts of Spatially Separated Markets. LAP Lambert Academic Publishing, Germany

Moledina, A.A., Roe, T.L. and Shane, M., 2002. Measuring Commodity Price Volatility and the Welfare Consequences of eliminating Volatility, Working Paper, USDA/ERS and the Economic Development Center, University of Minnesota, USA. http://faculty.apec.umn.edu/troe/documents/CommodityPriceVolatilitypdf.pdf

Kilima, F.T.M., Chung, C., Kenkel, P. and Mbiha, E.R., 2008. Impacts of Market Reform on Spatial Volatility of Maize Prices in Tanzania. *Journal of Agricultural Economics, 59(2):259-270.*

Negassa, A., 1998. Vertical and Spatial Integration of Grain Markets in Ethiopia: Implications for Grain Market and Food Security Policies. Working Paper 9, Grain Market Research Project Ministry of Economic Development and Cooperation, Addis Ababa, Ethiopia. *http://pdf.usaid.gov/pdf_docs/PNACF611.pdf*

Nielson, M., Smit, J. and Guillen, J. 2009. Market Integration of Fish in Europe, *Journal of Agricultural Economics, 60(2):367-385*

Nyairo, N.M., Kola, J. and Sumelius, J. 2010. Impacts of Agricultural Trade and Market Liberalization of Food Security in Developing Countries: Comparative study of Kenya and Zambia, Agricultural Economists Association of South Africa (AEASA), Cape Town, South Africa. *http://ageconsearch.umn.edu/bitstream/96172/2/124.%20Impact%20of%20liberalisation%20in%20Kenya%20and%20Zambia.pdf*

Pindyck, R.O., 2004. Volatility and Commodity Price Dynamics, *Journal Food Marketing 24:1029–1047. http://web.mit.edu/rpindyck/www/Papers/Volatility_Comm_Price.pdf*

SADC, 2009. Measures to Address Food Security in the SADC Region. SADC Secretariat, Gaborone, Botswana. *http://www.sadc.int/fanr/food_security/docs/Measures%20to%20Address%20Food%20Security%20in%20the%20SADC%20Region.pdf*

Schrimper, R.A., 2001. Economics of Agricultural Markets, Prentice Hall

Syampaku, E.M. and Munsanje, 2011. Maize Commodity Trading Behaviour and Impact on Price in Zambia during the Period 2007 to 2011, Purchase for Progress Project, World Food Programme, Lusaka, Zambia

Wroblewski, J., Cook, J. and Cagley, H.J, 2009. Zambian Maize Price and Production Analysis, University of Washington, USA *http://evans.washington.edu/files/Evans%20UW_Request%2046_Maize%20and%20Zambia_09-03-2009.pdf*

Zyambo, S. 1993. What has gone wrong with Maize Marketing, Lusaka, Zambia. *Zambia National Farmers' Journal No.226.*